that a majority, and perhaps all, use the tube only as a winter resort, or for a retreat in the summer during the time of molting, though the testimony upon this point is by no means universal. There seems good reason, however, for believing that very nearly all desert their tubes during the spring and summer, at times, and wander in search of their prey. Indeed, there are indications that there are latitudinal, as well as seasonal variations in the habits of the family, *i.e.*, that in northern latitudes proportionately a greater number make no tubes than in southern latitudes. The latitudinal variation might be called generic, in that many species of the genus in northern latitudes hide away under stones, etc., making no tubes at all; while in southern latitudes many other species of the same genus construct tubes, some few using them habitually; many others temporarily. On the other hand, the seasonal variation might be called specific, in that most species, in any latitude, which construct tubes use them only during inclement seasons, or during periods of weakness. One species I have observed here, *Lycosa fatifera* Hentz, habitually uses its tube at all seasons; never, or very rarely, wandering in search of prey. I have many times watched them resting at the opening of the tube, waiting for passing insects. They will dart back into their tubes when alarmed. Hentz reported this species from Massachusetts and Alabama. I have made special investigations upon the species in North Carolina, with a view to establish, if possible, the identity of Hentz's species *fatifera*, and the correctness of his statement that it uses the tube habitually at all seasons. The species can be easily recognized from Hentz's description. The one I find here is the piceous variety, which Hentz reported from Alabama, and not the typical form from Massachusetts.—*Geo. F. Atkinson, University of North Carolina.*

EMBRYOLOGY.[1]

THE SEVERAL FUNCTIONS OF THE ENAMEL ORGAN IN THE DEVELOPMENT OF THE TEETH OF MAMMALS AND ON THE INHERITANCE OF MUTILATIONS.— As long ago as 1880 Dr. A. Von Brunn[2] called attention to the fact that the cross crests of the crowns of the molars of the common grey rat were not completely covered with an enamel coating before eruption. The figures then published by Von Brunn showed that the *membrana adamantina* of the enamel organ possessed the characteristic columnar structure

[1] Edited by Prof. Jno. A. Ryder, Univ. of Penna,, Philadelphia.

[2] Notiz über unvollkommene Schmelzentwickelung auf den Mahlzähnen der Ratte Mus decumanus. Arch. f. mik. Anat. XVII., pp. 241–243, pl. XXVII.

over those portions of the tooth covered by true enamel, while at the apices of the cross crests the enamel organ had suffered degeneration of its inner columnar layer and apparently also the reticular portion, as a result of which the organ, just over the crests, had acquired the character of a stratified squamous epithelium. Here and there ragged masses of this tissue seemed to project into the surrounding tissues of the mucous membrane, as if dragged out of place by the gliding of the crowns of these young molar teeth of opposite jaws over each other. These results were obtained from a study of longitudinal sections of recently born rats, with the eyelids still closed, but with the incisors just breaking through the gums.

The great value which the present reviewer attaches to Dr. Von Brunn's earlier observations does not lie in the new histological relations established, but in the discovery that the enamel of the cross-crests of the crowns of the molars fails to develop in the embryo in a situation corresponding to the point where abrasion in the adult through use has slowly worn away this enamel covering and exposed the dentine underneath. This mutilation (for such it is, although produced by an exceedingly slow process of wear), has very clearly been transmitted through heredity. That Dr. Von Brunn should have failed to draw this conclusion from his facts is somewhat surprising, and while glad to call attention to his very important observations, the present writer is of the opinion that these discoveries are amongst the most important made during the present decade as throwing new light upon the method of the evolution of organisms.

In a second memoir [1] Dr. Von Brunn continues his investigations, and adds greatly to his preceding observations. He finds, in fact, that in still earlier stages of the enamel organs of the several kinds of teeth are not different from those normally observed in other mammals, as shown by the tooth germs of the incisors of a uterine embryo of the rat 28 mm. in length. The enamel organs in this last instance are simply cap or dome-like bodies, in which there is as yet no differentiation of the anterior wall as the permanent enamel germ of the enamel band on the anterior face of the incisors of the adult. This is clear proof that profound changes must be suffered by the enamel organ from its earliest appearance until its full differentiation, portions of which evidently must later become either functionless or acquire a new or modified function. This is just what Von Brunn's later researches most conclusively prove. They show, in fact, that in the rat the enamel organ becomes functionless across the transverse crests of the molars before eruption, thus leaving the tooth to erupt with its dentine uncovered at those points. The remainder of the enamel organ which

[1] Ueber die Ausdehnung des Schmelzorganes und Seine Bedeutung für die Zahnbildung. Arch. f. mik. Anat. XXIX. Hft. 3. pp. 367-383, pls. XXI-II, Bonn. 1887.

forms the enamel of the crowns of the molars develop hard enamel, but the portion which extends down over the root and cervix of the molars undergoes degeneration, and its cells lose their columnar form and degenerate into radiating fibres of considerable length, which send their free ends into the surrounding alveolar periosteum. These fibres persist even to adult age, and can be readily seen extending from the tooth into the wall of the alveolus in sections of the entire heads of adult white mice (*Mus musculus*) prepared by the present writer during the last winter. These fibres evidently serve to securely anchor the teeth into the alveolus of the adult, so that the enamel organ is found to have not simply the function usually ascribed to it, but another equally important, namely, the production of these anchorage fibres. Still deeper down in the alveolus the extreme inferior edge of the cap or dome-like enamel organ seems to become quite degenerate and functionless. Such functionless marginal portions of the enamel organ are found in the young of man, the ox, and the rat and mouse. The enamel organ is regarded by Von Brunn in fact as a sort of mould in which the dentine or pulp covered with odontoblasts assumes a definite form. Von Brunn concludes his second memoir with the observation that he considers that he has shown that in the Mammalia, wherever dentine is developed, that the epithelial sheath or cap concerned in the formation of enamel must have first existed. This explains the existence of the enamel organ in the armadillo (Tomes, Q. Jour. Mic. Sci., 1874).

The enamel-forming portion of the enamel organ, after eruption of the molars, is, of course, cast off entirely, or at most persists only as the *enticula dentis*. The portion giving rise to the anchorage fibres of the root persists, as may be seen in longitudinal sections of the molar teeth of adult animals in place in the jaw. In the incisors of the rat, on the contrary, the enamel organ has a more complex history. While it does not differ entirely from the germs of the other teeth in an early stage of development, as all parts of its wall are alike thick, later the anterior wall of this primary enamel organ becomes the persistent enamel organ of the enamel band on the anterior face of the incisors, and thickens, while over the sides and back of the tooth it degenerates and gives rise to the anchorage fibres of these teeth, as shown by Von Brunn, and as confirmed by sections of later stages in my possession.

While the data in which Von Brunn has supplied us are of great interest, there are some which I can add from stages of the development of the teeth of the common mouse, which are of interest in connection with the history of the form of the molars of these commonest of Rodents. A little while before birth the enamel organs of the first and second molars are connected by an isthmus, and it is probable that the germs of the second and third molars are also thus joined together. In longitudinal sections of the heads of young mice it is, however, of great interest to note that the cross crests of the upper molars have their apices directed

backwards and downwards, while the apices of the lower molars slope forward and upward, just as they do in the adult, yet at this stage there has been no enamel or dentine formed. This fact shows that the forms of the crowns are foreshadowed in the germs of the teeth before calcification, and it now becomes possible to assume, for the first time with a reasonable show of probability, that this forward and rearward deflection of the molars is due to an inherited impress or modification induced by the characteristic mode in which the grinding teeth were used in the Rodentia. Because it may be assumed that the manner in which the teeth are used would slowly affect pattern of the crowns, as the writer first tried to show in his essay "On the mechanical genesis of tooth-forms" (Proc. Acad. Nat. Sci. Phila., 1878). It follows that if physiologically induced mutilations may be inherited, as the results of Von Brunn seem to demonstrate, it is almost equally certain that mechanically induced changes of form slowly caused by the normal mode in which the teeth were used could be inherited with probably even greater readiness.

Dr. W. Xavier Sudduth has shown that the reticulum of the enamel organ becomes thinner at the apex of the young tooth. In this way he has also shown that the *membrana adamantina* or inner tunic and outer tunic are approximated while the blood vessels from the adjacent connective tissue are pushed toward the enamel organ to supply it with nutriment and probably aid very considerably in the rapid deposit of the enamel from above, in just the same way as the vascular pulp would supply the conditions for the rapid deposition of the dentine from below. That the enamel organ of the fœtus is supplied by a vascular plexus as assumed by Sudduth is, I think, completely demonstrated by the fact that I find a fine vascular plexus in immediate external contact with the persistent enamel organ of the incisor teeth of the adult white mouse.

The great value which is to be attached to the fact that abrasions of the enamel of the adult, which have reacted upon the funtional activity of the enamel organ of the embryo rat, so that such mechanically induced alterations could be inherited, does not consist so much in the proof it affords that mutilations may be inherited as it does that mutilations incurred in the ordinary struggle for existence, may, under certain conditions in certain practically feral species, be transmitted. The cases which have hitherto been appealed to as proving that mutilations could be inherited are without exception artificial; in the remarkable example of the already abraded apices of the molars of young mice and rats, we have an example of the apparently constant transmission of a mutilation quite independent of any artificial interference whatever. This datum, which has until now been wanting, is therefore at last supplied, and Lamarckianism has found in this the most irrefragable proof of the soundness of its principles. This datum, in fact, is the one needed, as admitted by Weissman, the greatest recent opponent of Lamarck, to place the latter's doctrine in the positions of formidable rivalry to those of Darwin. — *J. A. Ryder.*